

2021 Lyme and Other Tickborne Diseases Surveillance Report

Division of
Infectious Disease
Epidemiology

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DEPARTMENT OF HEALTH

Table of Contents

Introduction	3
Overview	3
Methods	4
Lyme Disease Findings	5
Tickborne Rickettsial Infections Findings	13
Babesiosis Findings	18
Tick Surveillance	22
Citations	26

Introduction

Lyme disease (LD) is a tickborne disease caused by the bacterium *Borrelia burgdorferi*. It may be transmitted by the bite of *Ixodes scapularis* ticks, also known as blacklegged ticks or deer ticks, if the tick carries the bacteria.¹ Early symptoms, typically occurring in the first 3 to 30 days after a tick bite, include fever, headache, and a rash, sometimes with a distinctive bull's eye shape, known as erythema migrans (EM). The EM rash is not present in approximately 20–30% of cases. Disseminated symptoms, typically occurring days to months after the tick bite, include joint pain and swelling, several EM rashes anywhere on the body, heart palpitations or irregular heartbeat, dizziness, nerve pain, facial palsy, and short-term memory loss. Most cases of Lyme disease can be successfully treated, especially when identified early. Delaying treatment can lead to heart and nervous system-related symptoms.²

In the United States, LD is the most common tickborne disease. Transmission of LD occurs primarily in the Northeast and upper Midwest regions of the country. In 2020 (the most recent year for which data are available), only 15 states reported 91% of all LD cases. In 2020, Pennsylvania reported more LD cases than any other state. Pennsylvania has a large population, so the incidence of cases per 100,000 population was sixth following Maine, Rhode Island, West Virginia, Delaware, and New Jersey in 2020.^{3,4} However, states where LD is endemic use a variety of surveillance approaches, making it difficult to make direct comparisons among states.

Other tickborne diseases can occur in Pennsylvania. The most common of these are anaplasmosis, ehrlichiosis, and spotted fever rickettsiosis (SFR). Anaplasmosis is caused by *Anaplasma phagocytophilum* bacteria, while ehrlichiosis is caused by species of *Ehrlichia* bacteria. Anaplasmosis is transmitted by the *Ixodes scapularis* tick, the same tick that transmits LD. Ehrlichiosis is transmitted by the lone star tick (*Amblyomma americanum*). SFR is caused by species of *Rickettsia* bacteria and is transmitted by the American dog tick (*Dermacentor variabilis*).^{5,6,7}

Babesiosis is an emerging tickborne disease in Pennsylvania. Babesiosis is caused by the parasite *Babesia microti*. *B. microti* is transmitted by *I. scapularis* ticks, the same ticks which transmit LD.⁸ Babesiosis is not currently reportable in Pennsylvania, so the Pennsylvania Department of Health (DOH) relies on labs and facilities to voluntarily report cases. Therefore, these data are estimates and may be an undercount of the true burden of disease.

Overview

In 2021, 2,900 LD cases were reported in Pennsylvania, representing an incidence of 22.4 cases/100,000 persons. Most were reported between May and August, with 46.1% reported in June and July. Fifty-eight of 67 counties in Pennsylvania reported LD, ranging from 0 cases in nine counties to 403 cases in Chester County. Incidence ranged from 0 cases/100,000 persons in nine counties to 250.1 cases/100,000 persons in Susquehanna County.

In 2021, Pennsylvania reported 683 anaplasmosis cases, 15 ehrlichiosis cases, 8 SFR cases, and 104 babesiosis cases.

It should be noted when viewing these data that the COVID-19 pandemic continued to be a public health priority for Pennsylvania in 2021 and significantly affected case counts for all reportable diseases, including tickborne diseases. The reasons for this are twofold. One, evidence indicates that fewer persons had laboratory testing conducted for LD and other tickborne diseases in 2021. This may have been due to concerns about exposure to COVID-19 in healthcare facilities. Virtual visits with healthcare providers became more common in 2020 and 2021 because of the pandemic, and persons may have been diagnosed based on symptoms without laboratory testing. These cases were generally not reported to DOH. Secondly, per the CDC case definition in use in 2021 (<https://ndc.services.cdc.gov/>), all tickborne diseases require a combination of positive laboratory results and positive symptom presentation to determine that they are cases. Due to the time public health staff devoted to the COVID-19 crisis in 2021, significantly fewer LD cases were able to be investigated in 2021 and could not be classified as true cases. It is likely many would have been classified as confirmed or probable cases had PA DOH been able to obtain the symptom information. This means that 2021 Lyme and other tickborne disease case counts were significantly lower than expected and almost certainly do not represent the true burden of disease in Pennsylvania in 2021.

Methods

Cases of LD, anaplasmosis, ehrlichiosis, and SFR, as well as positive laboratory test results for these diseases, are reportable by providers and laboratories to the DOH per Chapter 27 of the Pennsylvania Health and Safety code.⁹ Upon receiving the report, state public health nurses or county/municipal health department staff attempt to collect more information about the case from the ordering physician. The investigator then determines if the reported case meets the Council of State and Territorial Epidemiologists (CSTE)/Centers for Disease Control and Prevention's (CDC) surveillance case definition. National case definitions, which are designed for standardization of national case counting and are not intended for diagnostic purposes, can be found at <https://ndc.services.cdc.gov/>.

Cases that were designated as confirmed or probable according to the CSTE/CDC case definition are included in the case counts described in this report. In addition to comparing case counts to those from previous years, seasonal trends, geographic location, and characteristics of cases were analyzed. Population data for 2021 were obtained from the Pennsylvania Department of Health Bureau of Vital Statistics. Age adjusted calculations were made using case counts by age group and age group population data.

DOH also conducts syndromic surveillance of visits to Pennsylvania emergency departments and collects these data via the EpiCenter application, hosted by Health Monitoring Systems. EpiCenter collects de-identified data from most hospitals in Pennsylvania to monitor trends in reason for visits. In 2021, data regarding date and reason for visit, home zip code, and other information were obtained from 98% of emergency departments in the state. This information was analyzed to determine seasonal trends in tick-related emergency department visits.

Chief complaints were searched for the presence of terms, such as “tick,” “tick bite,” and variant spellings that indicated the patient had found a tick on their body or was bitten by a tick. Chief complaints, such as “Lyme,” “Lymes,” and discharge diagnoses related to Lyme disease were selected to identify ED visits related to LD.

Lyme Disease Findings

Annual Trends

In 2021, 2,900 LD cases were reported in Pennsylvania. This represented an incidence of 22.4 cases/100,000 persons in Pennsylvania and was a 13% decrease from the 2020 case count. In 2020, Pennsylvania reported 18.5% of all confirmed LD cases in the United States and ranked first in number of cases reported and sixth in incidence. Although there is an overall increase for LD reported cases and incidence nationally over the last decade, in 2020, LD cases decreased in many Lyme endemic states as all states were significantly affected by the COVID-19 pandemic.¹⁰ The long-term national trend in increasing cases may be due to expanded habitat for *Ixodes scapularis* and white-footed mice, which also harbor the *Borrelia burgdorferi* bacteria.¹¹ Additionally, *Ixodes scapularis* ticks are more likely to survive winter as the climate warms. Humans are spreading into rural areas to build homes and participate in leisure activities, making human and tick contact more frequent. Year to year variations are not unusual and may be related to changes in tick activity, white-footed mouse populations, and weather patterns. Table 1 shows the case counts by classification and total incidence by year for the last 10 years.

Table 1 – Lyme Disease Cases by Classification and Total Incidence per 100,000 Population, Pennsylvania, 2012–2021

Year	Lyme Disease Case Count			Population	Lyme Disease
	Confirmed	Probable	Total		Incidence per 100,000
2012	4146	887	5033	12,763,536	39.43
2013	5126	778	5904	12,773,801	46.22
2014	6470	1017	7487	12,787,209	58.55
2015	7655	1772	9427	12,802,503	73.63
2016	8988	2455	11443	12,784,227	89.51
2017	9250	2650	11900	12,805,537	92.93
2018	7920	2288	10208	12,807,060	79.71
2019	6763	2235	8998	12,801,989	70.29
2020	2641	693	3334	12,989,625	26.00
2021	2333	567	2900	12,964,056	22.37

Source: PA-NEDSS; DOH, Bureau of Vital Statistics

Seasonality

LD can be acquired year-round in Pennsylvania; however, most LD cases occur in the late spring and summer months. In 2021, 51.8% of cases with known onset dates reported that their onset of LD symptoms was in June or July. More people spend time outdoors and are more likely to come in contact with ticks in these months. In addition, *Ixodes scapularis* nymphs are most active in the late spring and early summer. Most cases of Lyme disease are attributed to nymphal ticks. Their small size makes them very hard to detect and remove in order to prevent Lyme bacteria transmission. Table 2 shows the months of onset of symptoms of LD by classification status. A higher proportion of confirmed cases were reported in June and July than probable cases. This is likely because acute cases of LD presenting with EM, a symptom which is diagnostic for LD, are more likely to be quickly diagnosed. Probable cases, which are defined by laboratory criteria and later-stage signs and symptoms, are more likely to be diagnosed after some time has passed.

Table 2 – Lyme Disease by Onset Month*, Pennsylvania, 2021

Month	Confirmed Cases	Probable Cases	Total
January	36	7	43
February	25	7	32
March	37	18	55
April	64	15	79
May	108	28	136
June	395	69	464
July	433	75	508
August	161	37	198
September	102	20	122
October	98	24	122
November	55	18	73
December	35	8	43
Total	1549	326	1875

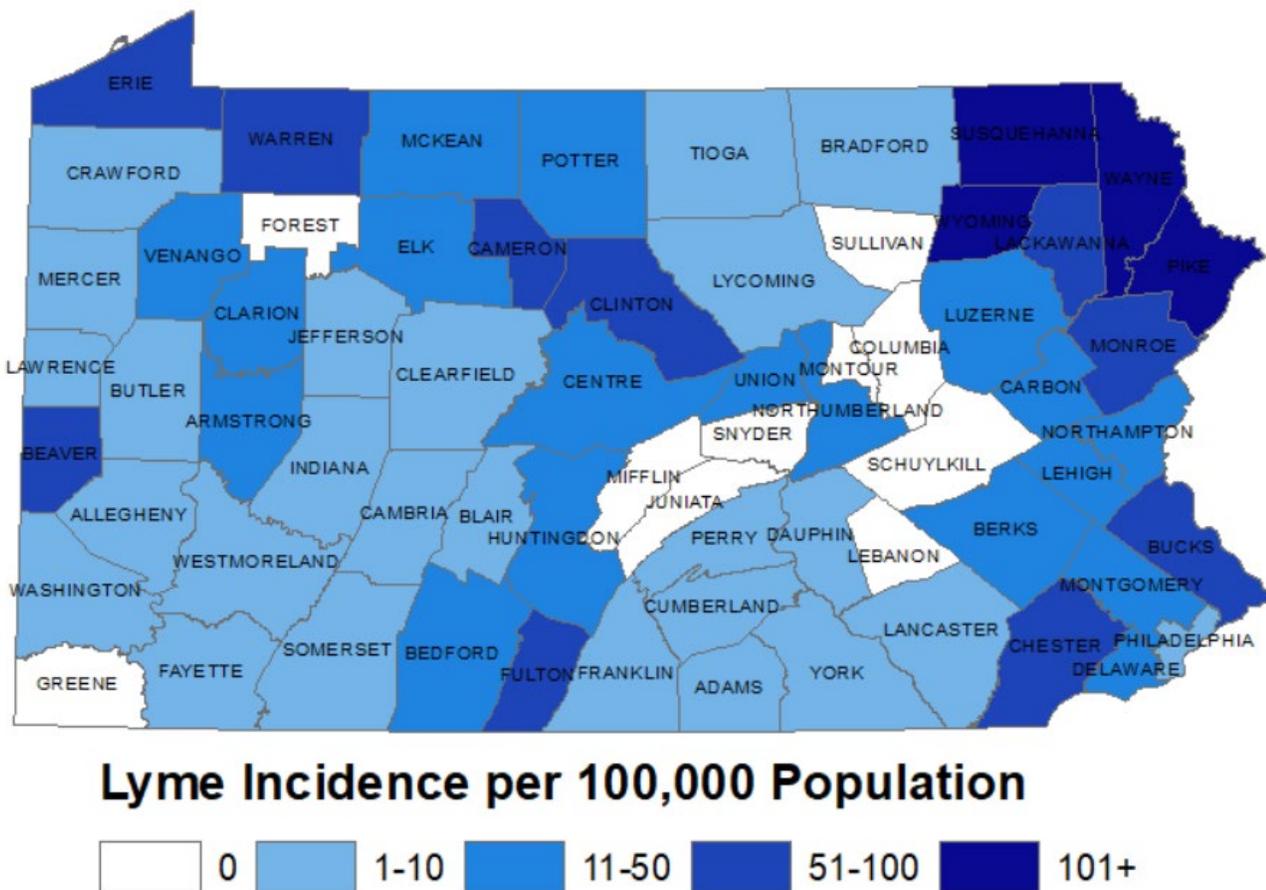
Source: PA-NEDSS

* Onset date is unknown for 35% of cases.

Geographic Distribution

Ixodes scapularis ticks infected with *Borrelia burgdorferi* have been found in all 67 counties in Pennsylvania. Persons have also been diagnosed with LD in all counties in Pennsylvania. LD incidence varies by county. Urban areas like Philadelphia tend to have a lower incidence than more rural counties. In addition, because classifying cases of LD requires data from providers to be reported to public health nurses in Pennsylvania’s health departments, case counts could appear lower in counties with lower staffing levels or in areas in which providers are less likely to respond to public health requests for information. Due to these surveillance complexities, the counties reporting the most cases may not actually have the greatest burden of LD. In 2021, counties in the northeast area of the state reported the highest incidence of LD. Map 1 shows the county incidence of LD cases in 2021. Table 3 shows the case counts by county in 2021.

Map 1 – Lyme Disease Incidence per 100,000 by County, Pennsylvania, 2021



Source: PA-NEDSS; DOH, Bureau of Vital Statistics

Table 3 – Lyme Disease Case Counts by County, Pennsylvania, 2021

County	Lyme Disease Case Count	County	Lyme Disease Case Count
Adams	*	Lackawanna	142
Allegheny	76	Lancaster	5
Armstrong	7	Lawrence	*
Beaver	116	Lebanon	0
Bedford	7	Lehigh	71
Berks	139	Luzerne	118
Blair	*	Lycoming	*
Bradford	*	McKean	10
Bucks	403	Mercer	*
Butler	*	Mifflin	0
Cambria	12	Monroe	117
Cameron	*	Montgomery	289
Carbon	31	Montour	0
Centre	18	Northampton	75
Chester	342	Northumberland	15
Clarion	16	Perry	*
Clearfield	*	Philadelphia	124
Clinton	22	Pike	86
Columbia	0	Potter	*
Crawford	*	Schuylkill	0
Cumberland	*	Snyder	0
Dauphin	*	Somerset	*
Delaware	88	Sullivan	0
Elk	5	Susquehanna	96
Erie	204	Tioga	*
Fayette	7	Union	12
Forest	0	Venango	7
Franklin	*	Warren	22
Fulton	12	Washington	*
Greene	0	Wayne	86
Huntingdon	5	Westmoreland	5
Indiana	8	Wyoming	45
Jefferson	*	York	10
Juniata	0	Total	2900

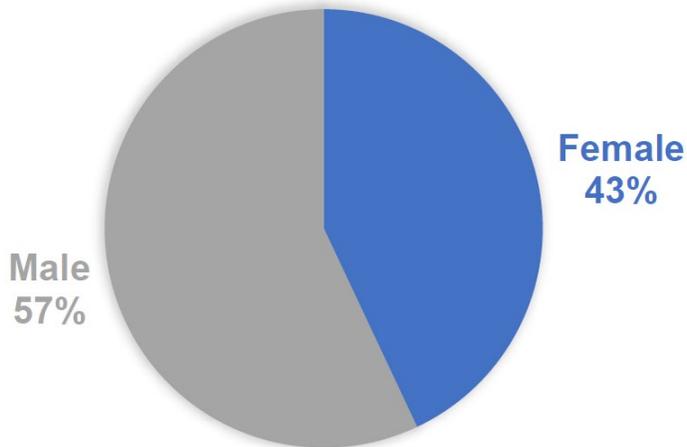
Source: PA-NEDSS

*Case counts <5 have been redacted to help protect patient confidentiality, in accordance with DOH policy.

LD Case Characteristics

Nationally, LD is more commonly diagnosed in males. This pattern was seen in the 2021 Pennsylvania LD data as well, with males comprising 57% of reported cases. Males may spend more time engaging in outdoor activities, such as camping and hunting, may be more likely to do yard work, and may be more likely to have jobs that require work outdoors. Figure 1 shows the sex distribution of LD cases in 2021.

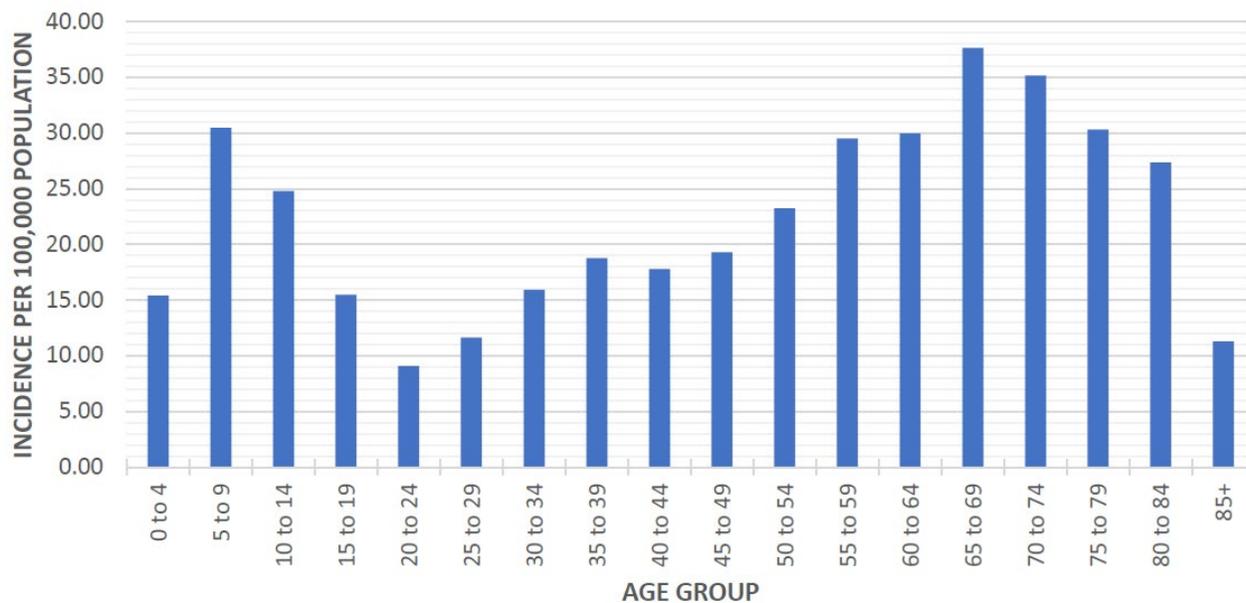
Figure 1 – Lyme Disease by Sex, Pennsylvania, 2021



Source: PA-NEDSS

LD incidence was highest in children ages 5–9 and in older adults. This is consistent with national trends. Hypotheses for this trend include children in the 5–9 year age group being more likely to play outside, are lower to the ground, may cuddle more with pets who might have ticks, are more likely to play in leaves and tall grass, and may be less likely to notice and report an attached tick. There is also a high incidence in older adults. The reason for this is not clear but may be due to more severe symptoms resulting in an increased likelihood to seek care for LD-related symptoms, increased time post-retirement to participate in outdoor leisure activities, such as dog walking, gardening, bird watching, and nature walks, or higher likelihood of testing due to overlap of LD and health concerns associated with typical aging. The age-adjusted LD incidence for 2021 is 22.4 cases per 100,000 persons. Figure 2 displays the incidence of LD by age groups in 2021.

Figure 2 – Lyme Disease Incidence by Age Group, Pennsylvania, 2021



Source: PA-NEDSS; DOH, Bureau of Vital Statistics

Clinical Manifestations of LD

Overall, 2778 cases reported symptoms related to LD. The EM rash is the most distinctive sign of LD; 47.4% of Pennsylvania cases in which the data were available were reported as having this classic rash. It should be noted that, according to CDC, EM is diagnostic for LD, and treatment should be initiated. Lab testing is not required in this circumstance, as serologic tests may be negative if done too soon after the onset of illness. Since most LD cases are reported to DOH by laboratories, it is likely many cases diagnosed based on EM alone are not reported to the department at all. Therefore, the proportion of cases with EM seen in our data are likely an underrepresentation of the true incidence of EM in LD cases. As noted earlier, there are several other signs and symptoms associated with different stages of LD. More serious complications of LD, like meningitis, encephalitis, and atrioventricular block, are rare. Table 4 shows the frequency with which the most common signs and symptoms of LD were reported in 2021. In cases in which the onset date of symptoms was reported, the median number of days between symptom onset and diagnosis of LD was eight days. However, onset date is not always reported and may be less likely to be reported in cases that have been experiencing LD symptoms for a longer period of time, since these cases may not remember when their LD symptoms began. The proportion of hospitalization among reported 2021 LD cases was 4.1%.

Table 4 – Signs and Symptoms of Lyme Disease Reported by Providers Among Lyme Disease Cases, Pennsylvania, 2021

Symptom	Percent (%) Who Reported	
	Experiencing this Symptom	Total Number of Cases
Erythema migrans (EM)	47.4	1317
Joint swelling	37.8	1049
Bell's palsy	5.0	139
Radiculoneuropathy	3.4	93
Lymphocytic meningitis	0.5	14
Encephalitis/encephalomyelitis	0.5	13
Second or third degree atrioventricular block	0.9	24

N = 2778

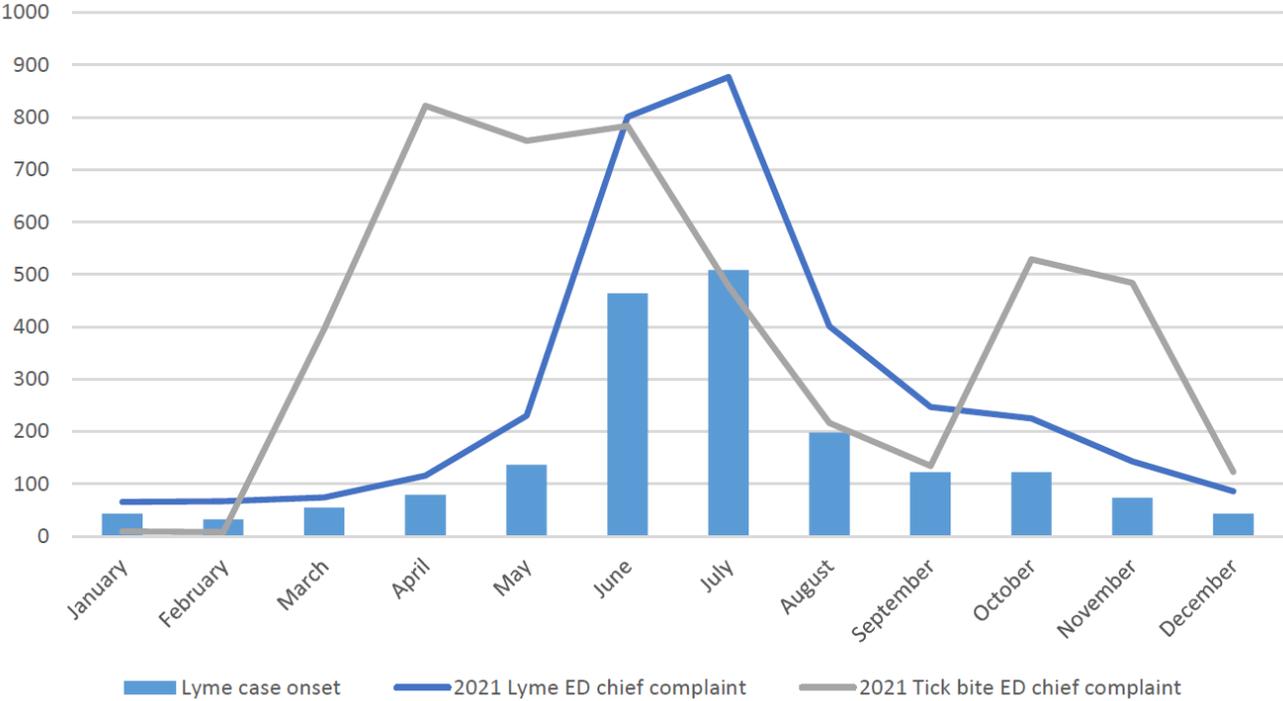
Source: PA-NEDSS

Emergency Department Surveillance Data

A review of syndromic emergency department (ED) surveillance data typically shows an increase in visits attributed to tick bites occurring in April each year when weather warms and people were more likely to spend time outdoors as is evident in the 2021 syndromic surveillance data. Spring tick bites are typically attributed to adult *Ixodes scapularis* and adult *Dermacentor variabilis* (dog ticks). *Ixodes scapularis* nymphs emerge in late spring and early summer. Tick bite complaints, which are inclusive of several species of ticks, are elevated during late spring and early summer despite *I. scapularis* adult activity decreasing. *I. scapularis* nymphs, however, are active from late May to mid-July, which corresponds with the spike in LD reports with onset date in June and July. These cases do not appear to be associated with visits to the emergency department (ED) for tick bites; it is possible that nymphal activity is less noticeable and results in fewer ED visits, although these bites still contribute to LD incidence. There is a second peak in tick-related emergency department complaints in the fall, which is consistent with the fact that adult *I. scapularis* ticks feed during October and November. Since tick bite-related emergency department visits peak prior to the peak of Lyme incidence, this indicates persons may be more likely to present to the emergency department with an adult tick bite than a nymphal tick bite.

Emergency department visits specifically related to LD increased in May 2021 reaching a peak in June and July, corresponding to the onset dates of reported LD cases. LD related emergency department visits are highly correlated to the timing of LD onset month and can be an early indicator of an increase in LD cases. Figure 3 shows the timing of tick-related and LD complaints reported in Pennsylvania emergency departments in 2021.

Figure 3 – Tick and Lyme Related Emergency Department Chief Complaints, Pennsylvania, 2021



Source: Health Monitoring Systems; PA-NEDSS

Tickborne Rickettsial Infections (TBRI) Findings (Anaplasmosis, Ehrlichiosis, Spotted Fever Rickettsiosis)

Annual Trends

Ehrlichiosis and Spotted Fever Rickettsiosis (SFR) case counts have been steady in Pennsylvania over the last 10 years, with counts typically ranging between 10–30 cases per year. Anaplasmosis, on the other hand, was infrequently reported a decade ago but has increased steadily to a high of 683 cases in 2021. Ehrlichiosis and SFR are transmitted by *Amblyomma americanum* (the lone star tick) and *Dermacentor variabilis* (the American dog tick), respectively. Anaplasmosis is transmitted by the *Ixodes scapularis* (deer tick), the same tick which transmits LD. Tick surveys have shown that the geographic range of *I. scapularis* has increased in Pennsylvania and the density of *I. scapularis* ticks has increased as well.⁸ This likely accounts for the increase in *I. scapularis* transmitted infections like anaplasmosis. In 2021, Pennsylvania reported 683 anaplasmosis cases, 15 ehrlichiosis cases and 8 SFR cases. Table 5 shows the case counts of these 3 tickborne diseases over the last 10 years.

Table 5 – Anaplasmosis, Ehrlichiosis and SFR Case Counts, Pennsylvania, 2012–2021

Year	Anaplasmosis	Ehrlichiosis	Spotted Fever Rickettsiosis
2012	8	23	41
2013	34	28	16
2014	25	10	7
2015	21	14	16
2016	58	23	22
2017	94	19	28
2018	108	18	25
2019	214	33	29
2020	216	*	*
2021	683	15	8

Source: PA-NEDSS

*Case counts <5 have been redacted to help protect patient confidentiality, in accordance with DOH policy.

Seasonality

Onset months of TBRI cases differ slightly from typical onset months of LD. Most cases occur in warm months, as ticks are most active in the warmer months and people are more likely to be outdoors and exposed to ticks during these months. Like LD, anaplasmosis cases are more likely to report onset dates in the warm months of May through July. Unlike LD, there is also another smaller peak in anaplasmosis in the cooler fall months of October and November when adult *I. scapularis* are feeding. This trend may indicate that adult *I. scapularis* ticks are more likely to transmit anaplasmosis than Lyme disease, possibly due to a shorter attachment time needed to transmit anaplasmosis from tick to host. Most ehrlichiosis cases report onset in May through August. However, SFR cases most commonly report onset in July through August. Table 6 shows the 2021 cases of anaplasmosis cases by month of report. Ehrlichiosis and SFR are transmitted by *A. americanum* and *D. variabilis*, respectively, which have different life cycles than *I. scapularis*.

Table 6 – Anaplasmosis Case Counts by Month of Onset, Pennsylvania, 2021

Month of Onset Date	Anaplasmosis
January	0
February	*
March	*
April	28
May	59
June	148
July	171
August	56
September	17
October	32
November	20
December	7

Source: PA-NEDSS

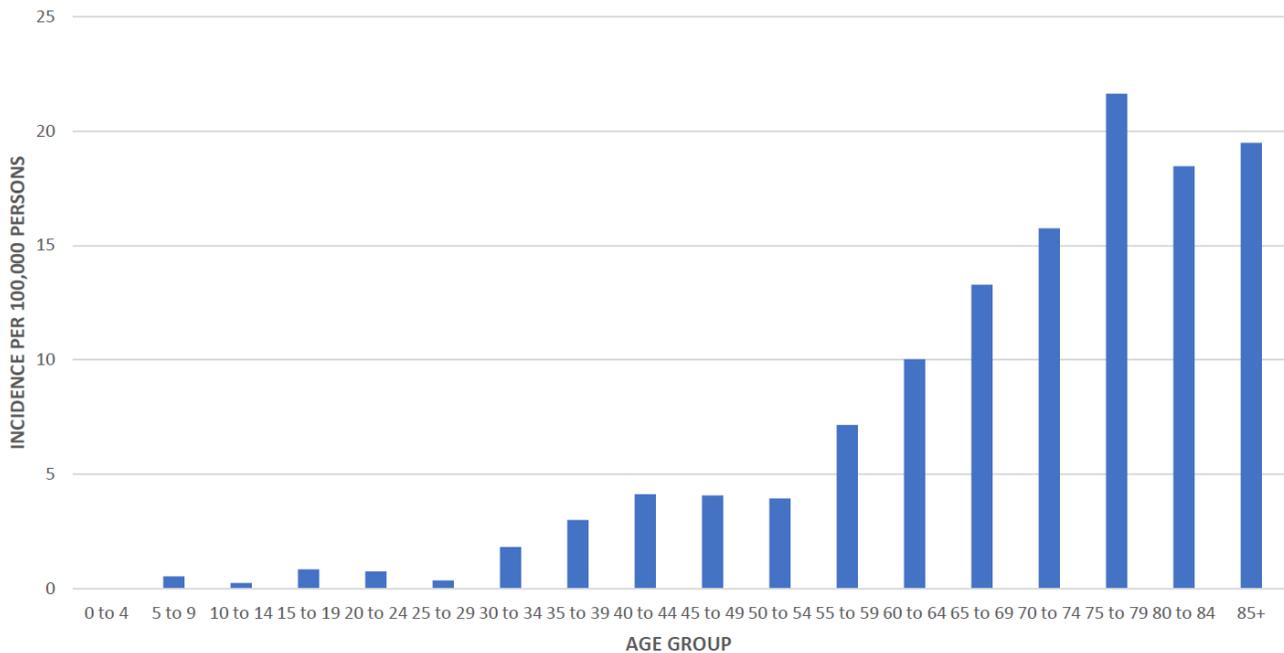
*Case counts <5 have been redacted to help protect patient confidentiality, in accordance with DOH policy.

Case Characteristics

Like LD, males are more likely than females to report these other tickborne diseases, with 66.4% of cases occurring in males. In both anaplasmosis and spotted fever rickettsiosis, we see more males than females affected, 66.8% and 60.0%, respectively. However, for ehrlichiosis, we see a slightly lower proportion in males, 50.0%, making ehrlichiosis cases evenly split between males and females.

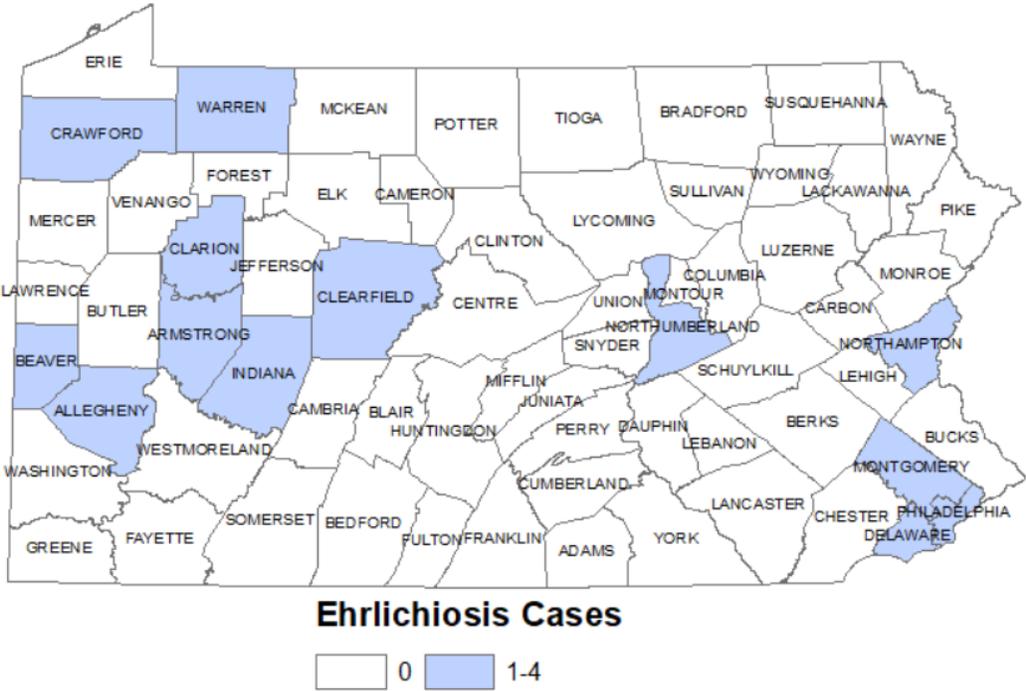
In LD, we see a high incidence in children and older adults. However, in TBRI cases, the incidence in young children was low, and there was a higher incidence in older adults and the elderly. The reason for this pattern is not clear, but it may be due to an exacerbation of symptoms in older age. Figure 4 shows the number of cases per 100,000 in each age category.

Figure 4 – Anaplasmosis, Ehrlichiosis and SFR Incidence by Age Group per 100,000 Persons, Pennsylvania, 2021



Source: PA-NEDSS and DOH Bureau of Vital Statistics

Map 3 – Ehrlichiosis Cases County, Pennsylvania, 2021



Source: PA-NEDSS

Map 4 – Spotted Fever Rickettsiosis Cases County, Pennsylvania, 2021



Spotted Fever Rickettsiosis Cases



Source: PA-NEDSS

Babesiosis Findings

Annual Trends

Babesiosis is not a reportable condition in Pennsylvania, therefore, reporting is voluntary rather than mandatory. As a result, it is not clear how well the data represent the true burden of babesiosis cases in Pennsylvania. Babesiosis is an emerging tickborne disease in Pennsylvania. Case counts appear to be increasing; however, it is unclear if the increase in case counts is associated with true case burden or due to labs and facilities opting to report more cases. In 2021, 104 babesiosis cases were reported in the state.

Table 7 – Babesiosis Case Counts, Pennsylvania, 2012–2021

Year	Babesiosis
2011	35
2012	11
2013	25
2014	11
2015	45
2016	36
2017	81
2018	72
2019	68
2020	40
2021	104

Source: PA-NEDSS

Seasonality

Since babesiosis is transmitted by the *I. scapularis* tick, the seasonality of babesiosis is similar to that of LD, with most cases reporting onset in June and July. There are also high case numbers in August which may be due to a longer incubation period which may last up to four weeks.

Table 8 – Babesiosis Case Counts by Month of Onset, Pennsylvania, 2021

Month of Onset Date	Babesiosis
January	0
February	0
March	*
April	0
May	*
June	23
July	38
August	9
September	8
October	*
November	*
December	*

Source: PA-NEDSS

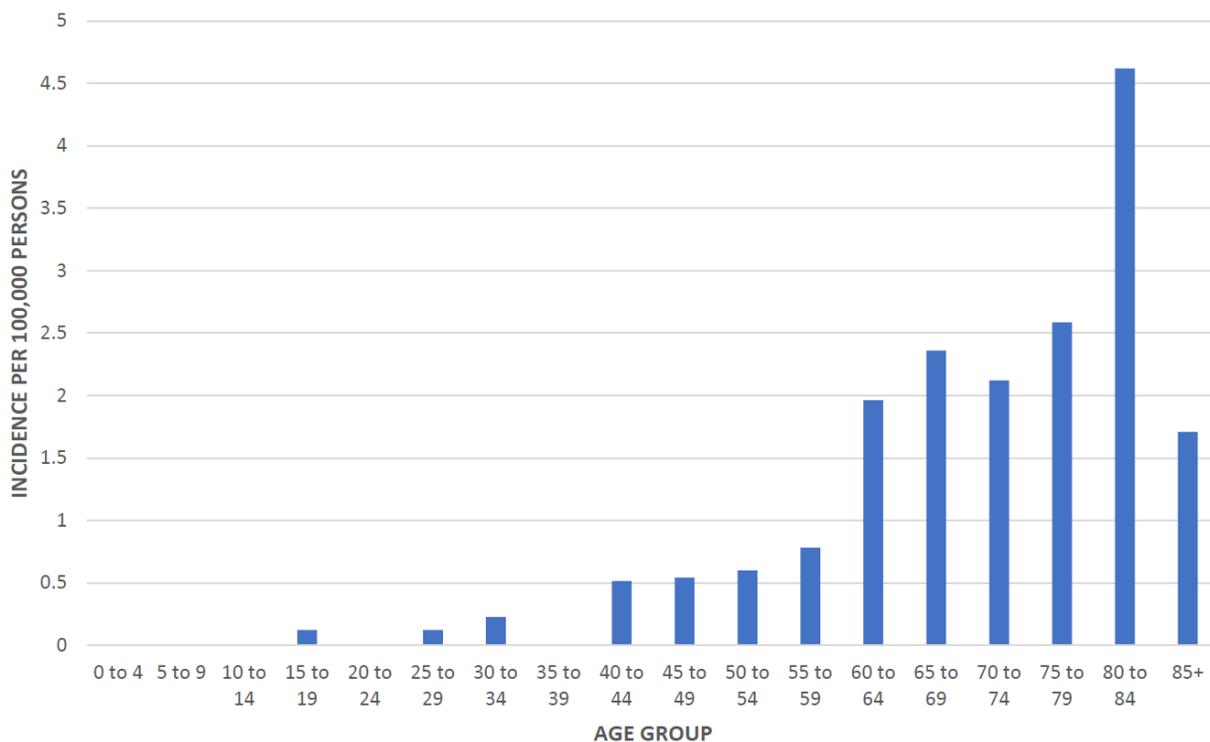
*Case counts <5 have been redacted to help protect patient confidentiality, in accordance with Pa. DOH policy.

Case Characteristics

Like LD, males are more likely than females to report babesiosis, with 69.2% of cases occurring in males.

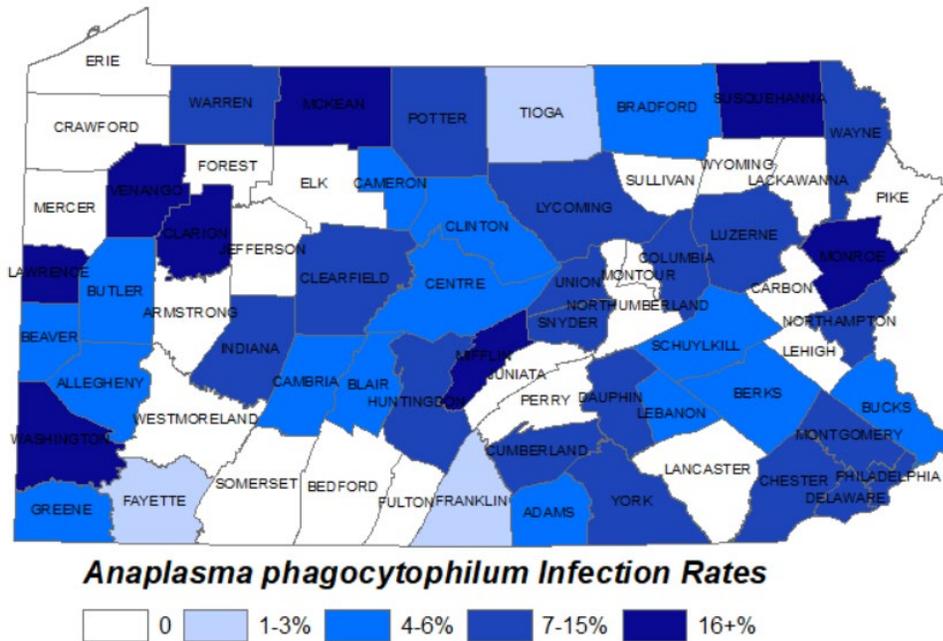
However, in contrast with LD but consistent with TBRI, the incidence in young children was low, and there was a higher incidence in older adults and the elderly. The reason for this pattern is not clear. Figure 5 shows the number of cases per 100,000 in each age category.

Figure 5 – Babesiosis Incidence by Age Group per 100,000 Persons, Pennsylvania, 2021



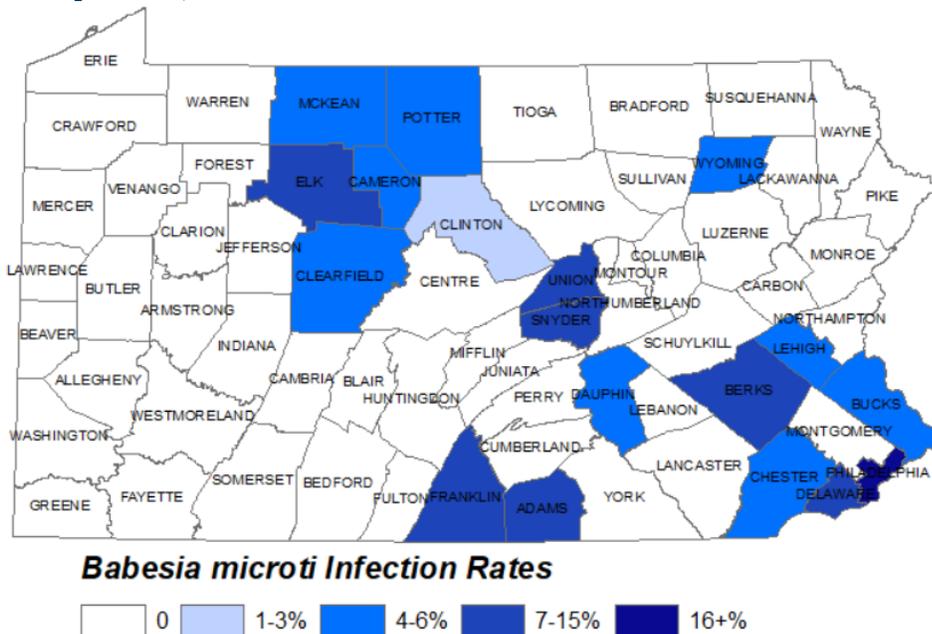
Source: PA-NEDSS and DOH Bureau of Vital Statistics

Map 7 – *Anaplasma phagocytophilum* Infection Rates in Nymph *Ixodes scapularis* by County, Pennsylvania, 2021



Source: Department of Environmental Protection

Map 8 – *Babesia microti* Infection Rates in Nymph *Ixodes scapularis* by County, Pennsylvania, 2021

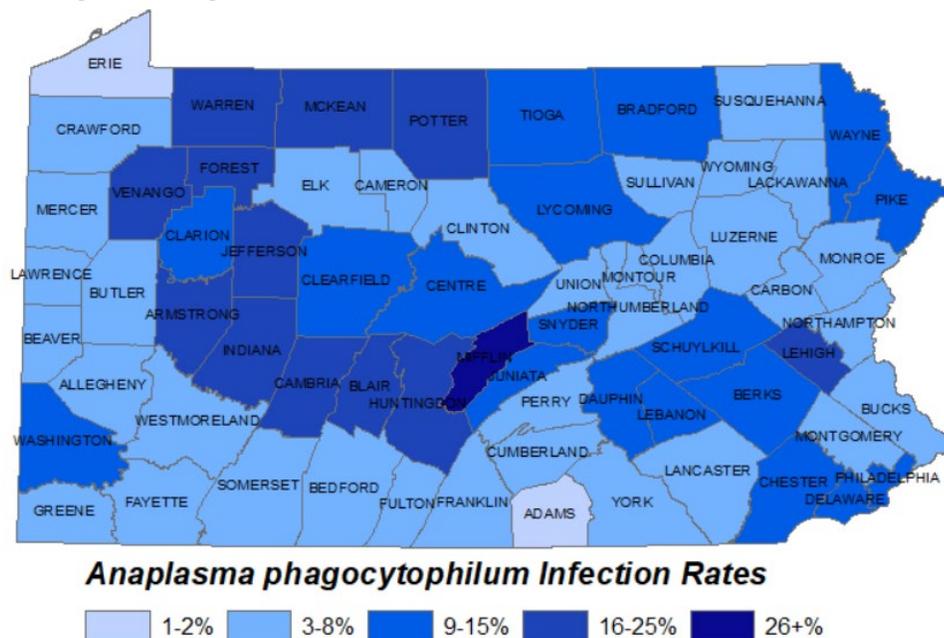


Source: Department of Environmental Protection

During the 2021–2022 adult *I. scapularis* season (October 2021 through April 2022), 4,978 adult *Ixodes scapularis* ticks were collected from all 67 Pennsylvania counties. Of these, 3,808 were tested for the rare or emerging *I. scapularis* pathogens including

Anaplasma phagocytophilum (the bacteria that causes anaplasmosis), *Borrelia miyamotoi* (the bacteria that causes hard tick relapsing fever), and Powassan virus. Rarer pathogens are more difficult to find in nymphs, as nymphs have only taken one blood meal from an animal that may be a reservoir for a bacterial, parasitic, or viral pathogen. Adult ticks that have taken two blood meals have about twice the likelihood of being infected with a pathogen. Among the ticks tested, statewide *A. phagocytophilum* infection rates were 10.2% and *B. miyamotoi* infection rates were 1.5% and Powassan virus infection rates were 3.0%. In three counties in 2021–2022, small areas with high Powassan virus infection rates were identified. Tick mitigation consistent with established methods was conducted in these areas. Maps 9–11 show the county infection rates of the adult *I. scapularis* ticks collected between 2021–2022.

Map 9 – *Anaplasma phagocytophilum* Infection Rates in Adult *Ixodes scapularis* by County, Pennsylvania, 2021–2022



Source: Department of Environmental Protection

Citations

- ¹ CDC. “Lyme Disease Transmission.” Last modified January 29, 2020.
<https://www.cdc.gov/lyme/transmission/index.html>
- ² CDC. “Signs and Symptoms of Untreated Lyme Disease.” Last modified January 15, 2021.
https://www.cdc.gov/lyme/signs_symptoms/index.html
- ³ CDC. “Lyme Disease Data Maps.” Last modified April 29, 2021.
<https://www.cdc.gov/lyme/datasurveillance/maps-recent.html>
- ⁴ CDC. “Lyme Disease Surveillance and Available Data.” Last modified May 5, 2021.
<https://www.cdc.gov/lyme/stats/survfaq.html>
- ⁵ CDC. “Anaplasmosis.” Last modified January 11, 2019.
<https://www.cdc.gov/anaplasmosis/index.html>
- ⁶ CDC. “Ehrlichiosis.” Last modified January 17, 2019.
<https://www.cdc.gov/ehrlichiosis/index.html>
- ⁷ CDC. “Rocky Mountain Spotted Fever.” Last modified May 7, 2019.
<https://www.cdc.gov/rmsf/index.html>
- ⁸ CDC. “Babesiosis.” Last modified March 31, 2020.
<https://www.cdc.gov/parasites/babesiosis/index.html>
- ⁹ Chapter 27 of the Pennsylvania Health and Safety code.
<http://www.pacodeandbulletin.gov/Display/pacode?file=/secure/pacode/data/028/chapter27/chap27toc.html&d=reduce>
- ¹⁰ CDC. “Lyme Disease Data Tables: Historical Data.” Last modified May 5, 2021.
<https://www.cdc.gov/lyme/stats/tables.html>
- ¹¹ Sonenshine, D. (2018) “Range Expansion of Tick Disease Vectors in North America: Implications for Spread of Tick-Borne Disease.” *Int J Environ Res Public Health*. Mar; 15(3): 478.